4.14

A LOCAL DATA INTEGRATION SYSTEM CONFIGURED FOR WEATHER SUPPORT IN EAST CENTRAL FLORIDA

John Manobianco* and Paul Nutter
ENSCO, Inc. / Applied Meteorology Unit / NASA
Kennedy Space Center, FL

1. INTRODUCTION

This paper describes the Applied Meteorology Unit's (AMU) efforts to install, configure, and test a local analysis system which assimilates all available data within 160 km of the Kennedy Space Center (KSC) and the Eastern Range at Cape Canaveral Air Station (CCAS). The ultimate goal for running a local data integration system (LDIS) is to generate products which may enhance weather nowcasts and short-range (< 6 h) forecasts issued in support of 45th Weather Squadron, Spaceflight Meteorology Group, and National Weather Service Melbourne operational weather requirements. A LDIS has the potential to provide added value because it incorporates data which are available only in east central Florida and is run at finer spatial and temporal resolutions over smaller domains than current national-scale, operational models (such as the Rapid Update Cycle; RUC).

The LDIS combines all available data in a dynamically consistent manner and produces gridded analyses of primary variables such as temperature, wind, etc. and diagnostic quantities such as vorticity, divergence, etc. at specified temporal and spatial resolutions. In this regard, the LDIS along with suitable visualization tools may provide users with a more complete and comprehensive understanding of evolving weather than could be developed by individually examining the disparate data sets over the same area and time. During the next year, the AMU will install, configure, and test a LDIS. Initially, the LDIS will not run in real-time; however, its potential added value to nowcasting/short range forecasting will be assessed by performing analyses on two selected days.

2. DATA INTEGRATION SYSTEM

There are currently two assimilation systems being considered as candidates for the LDIS. These include the Local Analysis and Prediction System (LAPS; McGinley 1995) and the ARPS (Advanced Regional Prediction System) Data Assimilation System (ADAS; Brewster 1996). LAPS is available from NOAA's Forecast Systems Laboratory (FSL; Boulder, CO) and ADAS/ARPS is available from the Center for Analysis and Prediction of Storms (CAPS) at the University of Oklahoma (Norman, OK). LAPS and ADAS can be configured to run at different horizontal/vertical resolutions over any geographic domain. In fact, both systems have been used to generate meso-beta scale analyses by assimilating a multitude of data including aircraft, radar, profiler, satellite, surface, and rawinsonde observations (Stamus and McGinley 1996; Droegemeier et al. 1996).

3. INITIAL CONFIGURATION

When configured for local use, it is anticipated that the LDIS will be run over an outer grid (inner) grid with a horizontal resolution on the order of 10 (2) km and at least 40 unevenly spaced vertical levels. The horizontal extent and distribution of grid points for the 10- and 2-km grids are shown in Figs. 1 and 2, respectively. The 10-km (2-km) analysis domain covers 400 x 400 km (160 x 160 km). The RUC will be used as background field for 1-h analyses of all observational data on the 10-km domain. Currently, the RUC assimilates observations every 3 h at a horizontal grid point resolution of 60 km with 25 vertical levels. NCEP is currently testing a 40-km, 40-level version of the RUC which assimilates observations every 1 h (Kalnay et al. 1996). The resulting 10-km products will then be used as background fields for analyses on the 2-km domain. This nested-grid configuration and cascade-of-scales analysis follows that used for the terminal winds analysis in the Integrated Terminal Weather System (ITWS; Cole and Wilson 1995). With such an approach, it is possible to analyze for different temporal and spatial scales of weather phenomenon measured by various sensors (section 4).

4. DATA COVERAGE / RESOLUTION

The utility of a LDIS depends to a large extent on the reliability and availability of both in-situ and remotely-sensed observational data. All observational data within 160 km of KSC/CCAS which can be incorporated by a LDIS are listed in Table 1. A representative distribution of the observational data listed in Table 1 is depicted in Fig. 3. The station or observation locations were obtained by collecting sample data sets on different days and times. Actual data values are not shown because Fig. 3 is designed only to illustrate approximate data coverage and resolution. The data availability, coverage, and density for each case study will likely depend on the days selected. Note that samples of visible satellite, aircraft/pilot and WSR-88D data coverage are not shown in Fig. 3.

Data density and coverage in east central Florida varies considerably depending on level in the atmosphere and distance from KSC/CCAS. The largest variability in horizontal/vertical coverage and density occurs with aircraft data, satellite soundings, and satellite winds. The maximum density of near-surface wind and temperature observations occurs at the center of the 2-km analysis domain with the KSC/CCAS tower network (Fig. 3a). The

**Corresponding author address*: John Manobianco, ENSCO, Inc., 445 Pineda Court, Melbourne, FL 32940. email: johnm@fl.ensco.com.

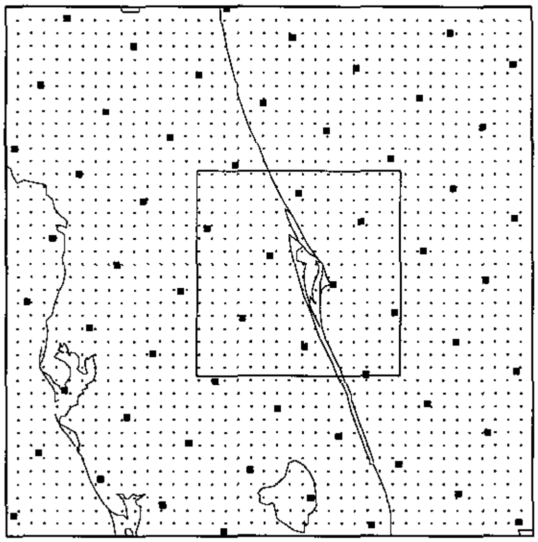

Figure 1. Proposed domain for the 10-km analysis grid. Grid point locations are given by dots. Squares denote 60-km RUC grid point locations. The outline of the 2-km domain is shown by the inner square.

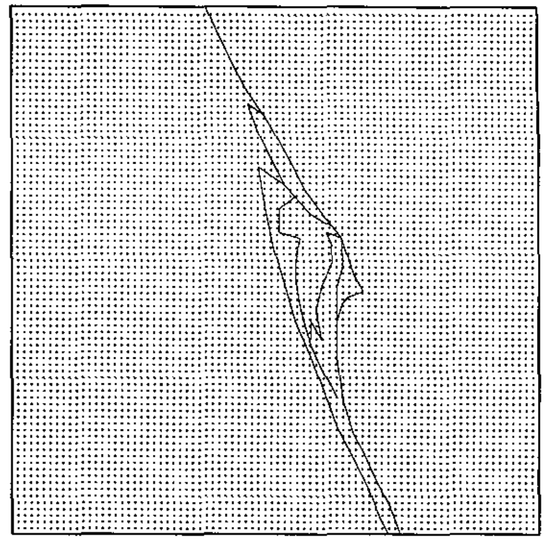

Figure 2. Proposed domain for the 2-km analysis grid. Grid point locations are given by dots.

TABLE 1. Summary of available data including source, variable, frequency and reference (if appropriate).

Data Type	Data Source	Variable	Frequency (min)	Reference
GOES-8 Satellite				
VIS/IR imagery	CCAS MIDDS	brightness T	15	Menzel and Purdom (1994)
Soundings	NESDIS ORA/FPDT	T, q	60	Gray et al. (1996)
Cloud drift winds	NESDIS ORA/FPDT	u, v	360	Neiman et al. (1997)
Water vapor winds	NESDIS ORA/FPDT	u, v	360	Veldon et al. (1997)
Surface				
METAR	CCAS MIDDS	u, v, T, T_d, p	60	----
Buoy/ship	CCAS MIDDS	u, v, T, T_d, p, SST	60	----
KSC/CCAS towers	CCAS MIDDS	u, v, T, RH	5	----
Central Florida mesonet	NWS Tampa, FL	u, v, T, T_d, p	60	http://www.marine.usf.edu
Upper Air				
Rawinsonde	CCAS MIDDS	u, v, T, RH	720	----
Radar				
WSR-88D	NWS Melbourne, FL (Level II archive)	radial wind, reflectivity	6	----
Aircraft				
Aircraft/pilot reports	CCAS MIDDS	u, v, T, ICE, TURB, cloud	Variable	----
ACARS	NOAA FSL	u, v, T	7.5	Benjamin et al. (1991)
KSC/CCAS Profiler				
915 MHz / RASS	AMU	u, v, T_v	15	----
50 MHz	CCAS MIDDS	u, v	5	----

VIS = visible; IR = infrared; NESDIS = National Environmental Satellite Data and Information Service
ORA = Office of Research Applications; FPDT = Forecast Products Development Team
MIDDS = Meteorological Interactive Data Display System
u = east-west wind; v = north-south wind; T = temperature; T_d = dew point T; T_v = virtual T; SST = sea-surface T
RH = relative humidity; q = specific humidity; p = pressure; ICE = icing; TURB = turbulence
ACARS = Aeronautical Radio, Inc. (ARINC) Communications, Addressing and Reporting System
RASS = Radio Acoustic Sounding System

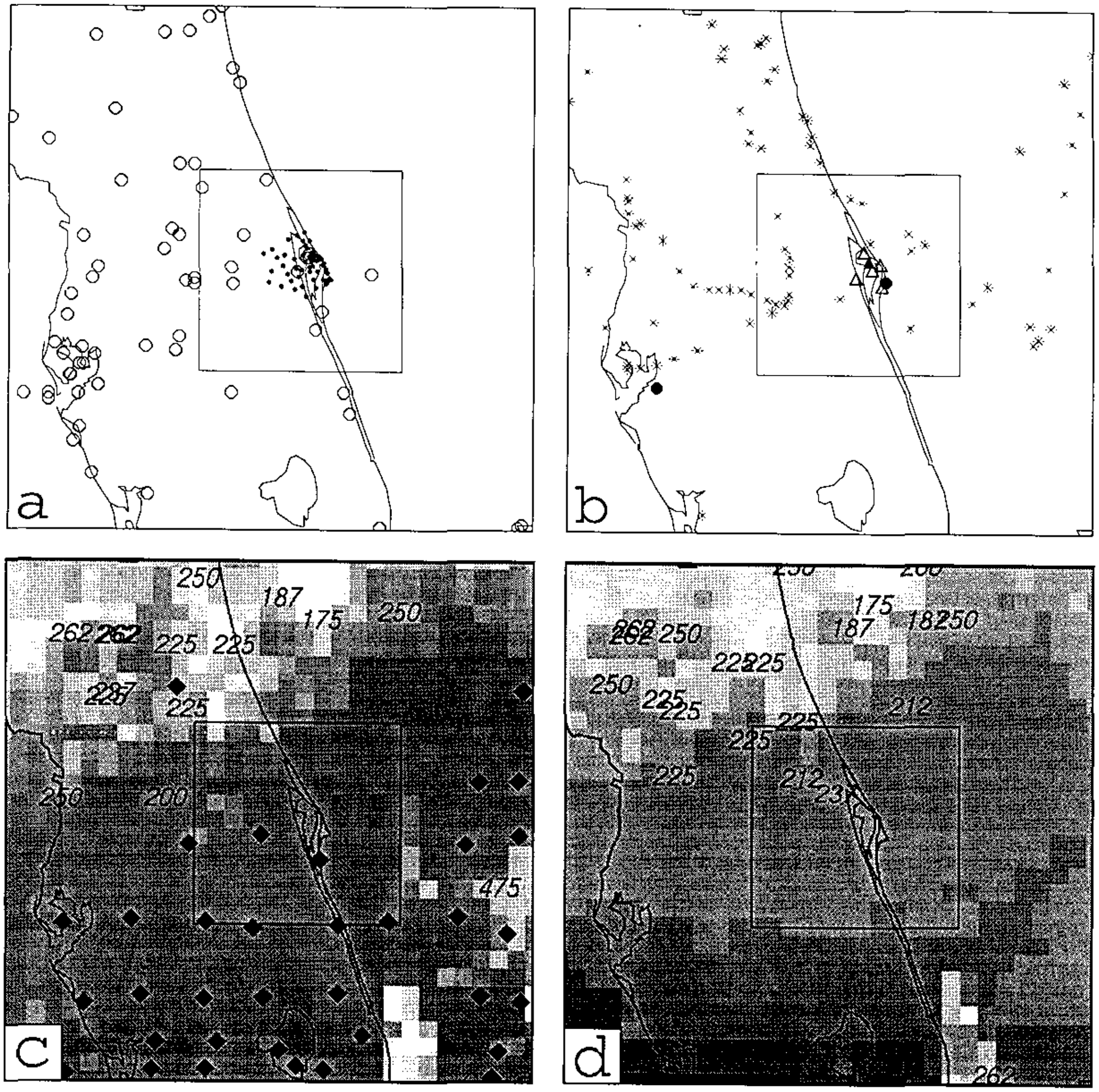

Figure 3. Sample distribution of selected observations listed in Table 1 with the 10-km and 2-km analysis domains shown in Fig. 1. Panel (a) shows METAR, buoy/ship and central Florida mesonet stations (octagons) and KSC/CCAS towers (filled circles). Panel (b) shows location of sample ACARS data (asterisks), rawinsondes (solid octagons), 915 MHz profilers (open triangles), and 50 MHz profiler (solid triangle). Panel (c) shows location of GOES-8 cloud-drift winds indicated by pressure level (mb) and GOES-8 soundings (solid diamonds) plotted over the GOES-8 IR image. Panel (d) shows the location of GOES-8 water vapor winds also indicated by pressure level (mb) plotted over the GOES-8 water vapor image. All satellite products are derived from GOES-8 data at 1045 UTC 25 September 1997. GOES-8 images are shown at a horizontal resolution of ~16 km.

distribution of other surface observations from METAR, buoy/ship and Florida mesonet stations shows a concentration over the central portion of the peninsula with almost no surface data available over the western Atlantic in either the 10-km or 2-km domain (Fig. 3a). The one 50 MHz and five 915 MHz boundary layer profilers (with Radio Acoustic Sounding Systems) are located around KSC/CCAS so they provide high temporal resolution wind and virtual temperature measurements over limited areas near the center of either analysis domain (Fig. 3b). Finally, the two rawinsonde sites at Tampa, FL and Cape Canaveral, FL (Fig. 3b) provide the least spatial and temporal resolution of all sensors listed in Table 1.

Commercial aircraft observations of wind and temperature are typically concentrated at flight levels in the upper troposphere and at lower levels during aircraft ascent/descent near airports (Schwartz and Benjamin 1995). The sample ACARS data plotted in Fig. 3b cover a

1-h period centered on 2200 UTC 12 May 1997 and represent the maximum number of observations available for a given hour on this day. These data were obtained from the experimental aircraft data display at NOAA FSL (http://acweb.fsl.noaa.gov).

Vertical profiles of temperature and moisture are retrieved hourly from GOES-8 sounder data at a horizontal resolution of ~50 km (Gray et al. 1996). However, soundings are available only in cloud-free areas so horizontal coverage can vary depending on the time of day, synoptic conditions, etc. The locations of GOES-8 soundings at 1045 UTC 25 September 1997 are plotted in Fig. 3c along with the corresponding GOES-8 IR image. GOES-8 soundings are concentrated primarily in the cloud-free zone oriented southwest-northeast across the southern half of the Florida peninsula.

The vertical and horizontal distribution of cloud-drift winds depends primarily on tracking cloud features and diagnosing heights to assign the vertical level for the associated wind (Neiman et al. 1997). The coverage of water vapor winds also depends on tracer selection and height assignment although water vapor wind vector targets are selected in both cloudy and cloud-free regions (Veldon et al. 1997). The locations of GOES-8 cloud-drift winds at 1045 UTC 25 September 1997 are plotted in Fig. 3c. A similar distribution of GOES-8 water vapor winds at the same time is shown in Fig. 3d along with the corresponding GOES-8 water vapor image. The vertical distribution of cloud-drift and water vapor winds is indicated by the pressure level plotted at the observation location (Figs. 3c and 3d). The heights of the cloud drift (water vapor) winds over the 10-km domain at 1045 UTC 25 September range from 475 to 175 mb (262 to 175 mb). In contrast to GOES-8 soundings, cloud-drift and water vapor winds are found where clouds and moisture features can be can be identified by the tracer selection and tracking algorithms (Neiman et al. 1997; Veldon et al. 1997).

5. ONGOING / FUTURE WORK

It is important to reiterate that the prototype LDIS will not initially be configured to run in real-time. The AMU will complete the installation/testing of the LDIS, develop software to reformat those data sets in Table 1 which are not currently ingested by the LDIS, select two case study days, collect/acquire all available data, and then run the analyses for each day. One day will be chosen with numerous interactions of mesoscale weather features across central Florida while an alternate day will be chosen when there is relatively little weather present. The case studies will be designed to highlight the capabilities and limitations of the LDIS and evaluate the impact of non-incorporation of specific data sources on the utility of the subsequent analyses. The presentation at the conference in January 1998 will focus on the configuration and testing of the LDIS and preliminary results from the case studies.

6. REFERENCES

Benjamin, S., K. A. Brewster, R. Brummer, B. J. Jewett, T. W. Schlatter, T. L. Smith, and P. A. Stamus, 1991: An isentropic three-hourly data assimilation system using ACARS aircraft observations. *Mon. Wea. Rev.*, **119**, 888-906.

Brewster, K., 1996: Application of a Bratseth analysis scheme including Doppler radar data. Preprints, *15th Conf. on Weather Analysis and Forecasting*, Norfolk, VA, Amer. Meteor. Soc., 92-95.

Cole, R. E., and W. W. Wilson, 1995: ITWS gridded winds product. Preprints, *6th Conf. on Aviation Weather Systems*, Dallas, TX, Amer. Meteor. Soc., 384-388.

Droegemeier, K. K., and Coauthors, 1996: The 1996 CAPS spring operational forecasting period: real-time storm-scale NWP, Part I: Goals and methodology. Preprints, *11th Conf. on Numerical Weather Prediction*, Norfolk, VA, Amer. Meteor. Soc., 294-296.

Gray, D. G., C. M. Hayden, and W. P. Menzel, 1996: Review of quantitative satellite products derived from GOES-8/9 imager and sounder instrument data. Preprints, *8th Conf. on Satellite Meteor. and Oceano.*, Atlanta, GA, Amer. Meteor. Soc., 159-163.

Kalnay, E., G. DiMego, S. Lord, H-L. Pan, M. Iredell, M. Ji, D. B. Rao, and R. Reynolds, 1996: Recent advances in modeling at the National Centers for Environmental Prediction. Preprints, *11th Conference on Numerical Weather Prediction*, Norfolk, VA, Amer. Meteor. Soc., J3-J8.

McGinley, J. A., 1995: Opportunities for high resolution data analysis, prediction, and product dissemination within the local weather office. Preprints, *14th Conf. on Weather Analysis and Forecasting*, Dallas, TX, Amer. Meteor. Soc., 478-485.

Menzel, P. W., and J. F. W. Purdom, 1994: Introducing GOES I: The first of a new generation of geostationary operational environmental satellites. *Bull. Amer. Meteor. Soc.*, **75**, 757-781.

Neiman, S. J., W. P. Menzel, C. M. Hayden, D. Gray, S. T. Wanzong, C. S. Veldon, and J. Daniels, 1997: Fully automated cloud-drift winds in NESDIS operations. *Bull. Amer. Meteor. Soc.*, **78**, 1121-1133.

Schwartz, B., and S. G. Benjamin, 1995: A comparison of temperature and wind measurements from ACARS-equipped aircraft and rawinsondes. *Wea. Forecasting*, **10**, 528-544.

Stamus, P. A., and J. A. McGinley, 1997: The Local Analysis and Prediction System (LAPS): Providing weather support to the 1996 summer Olympic games. Preprints, *13th Conf. on Interactive Information Processing Systems*, Long Beach, CA, Amer. Meteor. Soc., 11-30.

Veldon, C. S., C. M. Hayden, S. J. Nieman, W. P. Menzel, S. Wanzong, and J. S. Goerss, 1997: Upper-tropospheric winds derived from geostationary satellite water vapor observations. *Bull. Amer. Meteor. Soc.*, **78**, 173-195.